Impact of financial inclusion and Fintech adoption on the bank risk taking – evidence from the banking system in Pakistan

Ismail Abbasi[1], Abdur Rahman Aleemi[2]

1. **PhD Scholar, College of Business Management, Institute of Business Management, Karachi, Sindh, Pakistan**
2. **Associate Professor, Institute of Business and Health Management, Dow University of Health Sciences, Karachi, Sindh, Pakistan**

Corresponding email: ismailabbasi2@gmail.com

Abstract

This study explores the relationship between fintech adoption (FTA) and financial inclusion (F. Incl), and between FTA/ F. Incl and the Default risk, leverage risk and portfolio risk. This study performed empirical analysis on DR, LR, and PR, as well as fintech adoption and F. It included data. This study performed PCA factor analysis and then examined the relationship between the variables using panel data regression with OLS. This study used the Firm size (FZ), GDP growth (Gr) rate and the Interest rate (Ir) as the control variables. This study found and concluded that a very positive relationship exists between fintech adoption and the F. Incl of the data. At the same time, the fintech and Interest rate have inverse relations with the DR, LR and PR. At the same time, the F.Incl and the Interest rate have inverse relations with the DR PR and LR of the firm. Future studies can be done with more bank samples or sectors and more economies in the sample. Further research can be possible by using Islamic banks for separate studies, a multivariate analysis technique, or qualitative data collection methods. This study has examined the impact of FTA and F. Incl on the bank risk in the presence of control variables which according to our information neither study has checked so far this study has used the fintech adoption which different from the other variables this study has examined the banking sector by taking three risks at a time which according to our best of knowledge neither study has studied.

Keywords: *financial inclusion; fintech; default risk; leverage risk; portfolio risk; Bank risk*

Introduction

Financial inclusion (F.Incl) plays a vital role in broadening the financial base of the financial institutions in the country. (Ahamadou & Agada, 2023). There are various organisations which have defined F.Incl, but for this research, the definition given by the State Bank of Pakistan (SBP) will be used as "Fast and easy access to the financial services through the financial products which satisfy the customers through dignity and fair manner"(SBP, 2015). In many countries, F.Incl is being used by the Central Bank (CB) for the efficient and cheaper provision of financial

services to the common person. But while expanding the financial services for the people, Banks face certain kinds of risks such as credit risks, operational risks, cybersecurity issues, and compliance risks (Makina, 2019). At one end, F.Incl is trying to bridge the gap between the banks and customers, then at another end Introduction of Fintech Adoption (FTA) in the financial ecosystem is also exploring more markets and expanding the financial landscape of the country. But side by side, it is also producing similar risks to the financial institutions of the country.(Banna et al., 2022). Introduction of the BCT-enabled business processes, AI-based applications and QR-based cheque authentication system, use of mobile e-wallets, new payment gateways, e-accounts and e-cheques are a few innovations which are expanding the banks' customer base but constantly exposing the banks to various threats and risks. (Banna et al., 2021). In many studies, it has been found that FTA and F. Incl are both interdependent and in some studies, F.Incl is being used as the moderator variable.

This study aims to test the relationship between F. Incl and FTA and bank risk (BR). This study noticed that both factors are such that they can hinder the banks from making risky decisions while lending, corporate financing and trade transactions. This study will use both variables (FTA and F.Incl) as the independent variables to check the negative or positive effect of both variables on bank risk. The different component which constitutes the FI and the FTA are mentioned in the data analysis section, while the bank risk-taking is divided into three components, which are default risk, liquidity risk and Portfolio risk. The paper comprises 5 sections, which 1st section is the introduction. In 2nd section, the complete literature review of the past studies is given, after which the next section has an analysis of the data collected from the sources, while the last section has a discussion and conclusion of the research and presents results which have large implications for today's managers of financial institutions.

Literature review

The literature review part consists of different literature connected with each variable which is used in the study. This study will explain one by one each variable, and then the connection between the variables will also be identified by different studies.

Fintech Adoption

Fintech Adoption (FTA) has a different name in the literature some studies suggest its name as the digitalization (Metawa et al., 2023), (Arpita et al, 2023) as the development of the financial infrastructure or (Beck, 2020) the financial innovation, digital Financial inclusion (Banna & Alam, 2021) and (Shihadeh & Liu, 2019) while (H. Yang, 2019) used the term “Strategy” for it. In any case, the objective of the aforementioned studies is to gauge the impact of the innovation or the reengineering of the financial landscape of the country or region from

conventional finance to digital finance. Adequate literature is available which has tested the FTA influence on bank risk, while few studies found which have tested FTA with any other variable or in other contexts. For example, discussed the FTA in the context of digital technology thus it has been named digital financial inclusion. Similarly, (Shihadeh & Liu (2019) studied the FTA during this term. (Makina, 2019) has focused on the African region, but it has developed the digital financial inclusion (F. incl) index consisting of four key elements, which are digital devices, platforms for transactions, economic agents and digital financial products. Another African study (djoufouet & pondie, 2023) studied the same relation between the variables in 35 Sub-Saharan countries which found that mobile phone ownership affects the FI similar studies (Banna et al., 2021) and (Ahamadou & Agada, 2023) conducted in the context of the Islamic countries it has changed the term as FTA based financial inclusion (FFI) means it has changed the variable with it some dynamics of the way of conducting studies will also change it studied the impact of the FFI on the bank risk taking it found its positive behaviour. (Siddharth & Kumar, 2023) also checked the relation between the FTA and the FI by using the TAM model, but it produced the contribution by inserting the concept of sustainability in the research. It found a very strong relationship between the FTA and the sustainable FI. Similarly, tested the impact of FTA on the FI in India by using the behavioural finance constructs. It concluded that the FTA has impacted much on the nation, particularly the middle class, thus the FTA is the fastest growing trend resulting in the FI in India. Synonym of the FTA is the digitalization of the finance (Metawa et al., 2023) discussed the impact of the digitalization of the chosen banking firm on its credit risk, it used the FI as the mediator study concludes that initiating the digitalization in the banking products and operations reduces the risks directly and indirectly in the presence of the mediator variable of F.incl. Similar studies conducted by (F. Yang & Masron, 2023) used the FI as the moderator while bank profit as the mediator they checked the impact of the digitalization, named as digital transformation, on the credit risk of the bank. It found that banks' profitability increases due to the expansion of digital products and the digital innovation in the banking business processes the credit risks increase. Another report (Arpita et al, 2023) produced by the World Bank Group concludes that without the development of the financial infrastructure, which is the other name of FTA the FI cannot be achieved but the development of the financial infrastructure can increase the credit and insolvency risk for the financial sector. Various determinants of the FTA produce effects on it or are responsible for expanding it. These determinants are studied by (Ozili, 2023) (Aduba et al., 2022) and (Banna & Alam, 2021) who found that one of the prime factors which increases the FTA is the FI, it is the factor which is responsible for the rapid increase in mobile transactions and internet banking use.

Thus, by this discussion, this study assumes that FTA has inverse relations with the BR while FTA is also producing a direct effect on the FI so the first hypothesis is as follows,

H1: FTA has a significant and inverse relationship with the DR

H2: FTA has a significant and inverse relationship with the LR

H3: FTA has a significant and inverse relationship with the PR

H4: FTA has a significant and direct relationship with the F. Incl

Financial inclusion (F.Incl)

The Word financial inclusion (***F.Incl***) was first coined by Indian authors and used primarily for Indian villages in the Indian context (Noori et al., 2023) after 1950 all those countries which had large unbanked populations started *F.Incl* programs for the fast expansion of the banking services in the villages and the low-profile areas in the cities where the population was still using the old methods to invest and save. In Pakistan, the State Bank of Pakistan (SBP) also started the wave of *F.Incl* initiatives in which it made a strategy from time to time to update it according to the needs of the financial landscape of the country. This official document called as National Financial Inclusion Strategy (SBP, 2015) it defined *F.Incl* as " the initiative by the central bank for the provision of basic financial services to every person at low cost" Similarly IMF, ADB and other international monetary institutions have given detailed reports about the condition and strategy for achieving it. Side by side academia has also forwarded various studies which have analysed it from various angles.

Some studies have focused on the comparative analyses of the different geographical regions or cross-country analysis in financial inclusion research for example (Shihadeh, 2020) and (Banna et al., 2022) for the sub-Saharan African region investigated the impact of *F.Incl* on the bank risk in the MENAP region countries, its findings are very hopeful for the researchers as it indicates that *F.Incl* increases the efficiency and financial performance of the banks while its expansion constantly decreased the bank risk faced by the sector in the region. A similar study (Aleemi et al., 2023) tested the market power of the bank was conducted with the assumption of non-normality and with some conditions for Pakistani banks to test the impact of the FTA and the *F.Incl* on the bank's market power. It found FTA positive impact on the *F.Incl* and a negative impact on the bank market power. Similarly, another study (Ashenafi & Dong, 2022) has also used a very different variable for testing the impact of the FTA and *F.Incl* on income distribution in the African region. It concluded that there are country-specific factors and FTA has a positive impact on the *F.Incl* while the income inequality is eliminated due to the more FTA activities and *F.Incl* initiatives in the country. Similar results were found by (Demir et al., 2022) for the global financial system

taking 140 countries. (Musau et al., 2017) conducted the effectiveness test of the FTA and *F.Incl* on the credit risk of the bank in the Kenyan economy it found that the positive impact on the credit risk by the FTA and the *F.Incl* activities in the economy.

There are types of studies that focus on the FI's different dimensions for example review studies (Ozili, 2021) and (Noori et al., 2023), Islamic finance and *F. Incl* (Elzahi Saaid Ali et al., 2020) (Herrerias & Alvarez, 2023) for the financial inclusion and financial behaviour, development and *F. Incl* (Sarma & Pais, 2011) and research on the subject matter of the *F. Incl* such as index formation (Sarma, 2008) or (Allen et al., 2016) the research investigating the foundation and characteristics of the *F. Incl* such type of studies also concludes that the FI hurts the BR due to expansion of the banking services profitability and efficiency increases while these expansions of services need 5th generation technology like AI (Artificial intelligence), BCT(blockchain-based), Cloud computing and Cyber Security enabled solutions for the implementation and secure operations, thus study concludes that financial inclusion (F.Incl) has the positive direct relations with the FTA and digital transformation of the banking processes.

Thus, the above discussion guides us in the following hypothesis

H5: F. Incl has a significant and inverse relationship with the DR

H6: F. Incl has a significant and inverse relationship with the LR

H7: F. Incl has a significant and inverse relationship with the PR

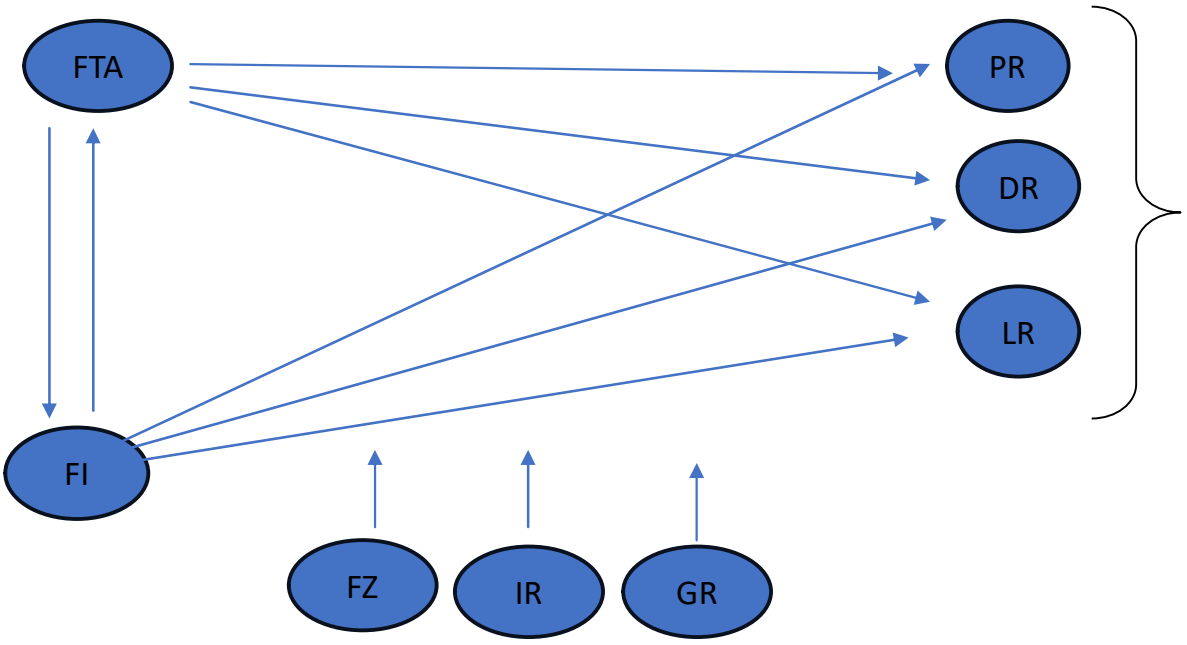
H8: F. Incl has a significant and direct relationship with the FTA

Bank Risk/Credit Risk (BR/CR)

There are several studies which have studied the risk in banking or digitalization context for example (F. Yang & Masron, 2023) studied the impact of the digital transformation on BR and found the negative correlation between the two showing the hope for banks reducing their future NPL (Non-performing loans) by diverting their resources into the digitalization of the credit and trade departments. In contrast (Wang & Liu, 2020) showed the positive impact of the FTA with the bank risk (BR) taking in U shape thus initially on the development of the fintech, BR taking increased after which it follows a negative trend. (Metawa et al., 2023) found two types of effect on the CR of the bank direct and indirect relations showing that digital transformation is producing a direct negative impact on the bank CR while the indirect effect on the CR is positive by using the F. Incl as the mediating variable. (Lihonga & Keda, 2022) showed that FTA has a negative impact to the bank risk associated with the inclusive finance activities in which banks are involved while implementing the F. Incl bank can improve its products and services by incorporating the FTA in the operations and the control and at other various business processes

it can bring the efficiency, more controlled, less risky and good financial performance at branch and head office level. (Elahi, 2022) checked the impact on the BR or CR of the FTA in three dimensions on the national state-owned banks and rural banks, the study found that FTA highly impacts the state-owned banks by impacting the operational efficiency, risk management system and the F. Incl of the banks. (Banna et al., 2022) and (Banna et al., 2021) conducted the study in the microfinance institutions in specific regions and Islamic countries. The financial institutions sector found that incorporating the FTA solutions in the banking business processes was responsible for the reduction of the BR. One benefit highlighted by a similar study (Banna & Alam, 2021) conducted for the cross-comparison between conventional and Islamic banks it found that the introduction of digital financial inclusion reduces the operational and credit risk to the Islamic banks and provides stability and efficiency in the operations of the banks. Not only by making bank's processes digital financial mobility and profitability increase but the BR which is composed of portfolio risk default risk and leverage risk also decreases. Some studies which have studied the relations of the ***F. Incl*** with the BR has shown diverse results (Shihadeh & Liu, 2019), (Shihadeh, 2020) studied the impact of the ***F. Incl*** with the BR showed that enhancing the FI will increase the bank profitability while decreasing the BR. Some studies have studied the impact of ***F. Incl*** *on* credit risk (CR) for example (Musau et al., 2017) found a significant negative impact of F. Incl on CR

2.4 Conceptual Framework of the Study



Methodology

Theoretical underpinning

The present study has used the theoretical background of risk-taking behaviour for the relationship between FTA and the BR or FR and BR while the theory of technology acceptance model is used to support the relationship between FTA and the F. Incl variables. This study has employed the positive Lens of philosophy to investigate the impact of the FTA and F. Incl on the Bank risk.

Data source

The present study has collected selected data of FTA and F. incl the year 2018 and beyond from the database of World Bank's Global Findex and IMF databases, while few FTA and F. Incl data has been collected from the Karandaaz portal and SBP reports, while macroeconomic data has been collected from the Pakistan economic survey 2018 – 2024.

Measures

Here in the below section, there is the complete detail of Dependent, Independent and control Variables.

Dependent variable

Table 1: Bank Risk

Proxies	Representation	Descriptions	Reference
Portfolio risks	It tells how much risk banks face for their portfolios	ROAA/σ (ROAA) where Return on Average Assets = Net income/ Net Assets (%)	Danisman and Tarazi (2020)
Leverage risks	It tells how much leverage the firm has	LR = EQT/σ (ROAA)	Lepetit et al. (2008)
Default risks	Z score is used to indicate default of the bank	Zscore = ROAAit+EQTit / SD (ROAA)it	(Aduba et al., 2022) (Banna & Alam, 2021)

This study took the data from the Pakistani banking industry of the last 5 years and calculated the three above-mentioned variables.

Independent variables

- **Fintech**

For the fintech measurement, this study created an index by selecting the different variables from the literature and the SBP data source, this study has formulated the index in the following way

Table 2: Fintech

S. No	*Name of the index*	*Descriptions of the variable*	*Reference*
1	No of M-Wallets Transactions	The total no of transactions performed by Mobile phone wallets on 1000 adult 15+ population	(Elgayar, 2023) (Aleemi et al., 2023)
2	No of Active Mobile Money Agents	mobile money agent on 1000 adult 15+ population	(Elgayar, 2023)
3	No of Mobile cellular subscriptions	Population with mobile technology (per 100 people)	(Aduba et al., 2022)
4	Percentage of the Individuals using the Internet (% of the population)	No of People who frequently use the Internet for finance	(Banna & Alam, 2021)
4	No of Internet banking transactions	No of People who Internet banking per 1000 individuals	(Aduba et al., 2022)
5	Number of mobile money accounts	No of mobile money accounts on 1000 adult 15+ population	(Lee et al., 2021)
6	No of OTC Transactions	number of OTC Transactions performed by the population on 1000 adult 15+ population	(Croutzet & Dabbous, 2021)

- ***Financial inclusion (F.Incl)***

For financial inclusion study has adopted the index from past studies and has made the unique index by incorporating the different variables according to the needs of the country. We took different variables, and their parameters are given below in the table.

S. No	*Name of the index*	*Descriptions of the variable*	*Sources*
1	No of ATMs installed	The total no of ATMs installed for the 1000 adults population	Sbp website and karaandaaz portal
2	number of bank branches	number of bank branches on 1000 adults 15+ population	Sbp website and karaandaaz portal
3	Number of Debit cards per 1000 adult	Population with debit cards per 1,000 adults	
4	Number of Credit cards per 1000 adult	No of People use Credit cards per 1,000 adults	Sbp website and karaandaaz portal
4	No of e-banking transactions	Actual no of e-transactions performed by population in the country.	Sbp website and karaandaaz portal
5	Reg Internet/Mobile Banking Users	No of mobile banking users on 1000 adults 15+ population	Sbp website and karaandaaz portal
6	Number of POS terminals	number of POS Terminals on 1000 adults 15+ population	Sbp website and karaandaaz portal

Control variables

For control variables three country-level variables were used as used in much previous literature are country growth (G) measured by the GDP growth rate, firm size (FZ) by the Natural logarithm of the Total Assets of the bank each year While Interest rate (IR) measured by the SBP policy rate of each year reported in the SBP monetary policy bulletin.

Econometric specifications

To investigate the relation between the variables following baseline regression was used after making factors and index of the FTA and the F.incl.

$$DR_{ij} = \alpha + BFTA_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij} \qquad LR_{ij} = \alpha + BFTA_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij}$$

$$PR_{ij} = \alpha + BFTA_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij}$$

While the regression for the F. Incl is as follows,

$$DR_{ij} = \alpha + BF.\ Incl_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij} \qquad LR_{ij} = \alpha + BF.\ incl_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij}$$

$$PR_{ij} = \alpha + BF.\ incl_{ij} + FZ_{ij} + Gr_{ij} + I_{ij} + \varepsilon_{ij}$$

Where the DR_{ij}, LR_{ij} *and* PR_{ij} are the default, leverage and portfolio risk of specific bank i of the year j, $BFTA_{ij}$ and $BF.Incl_{ij}$ are the FTA and the F.Incl of the specific year j and for the specific bank i, FZ_{ij} is the bank-specific factor which is the bank size while the I_{ij} is the interest rate and the Gr_{ij} is the growth of the economy for the specific bank i and for the year j

Testing technique

This study employed the PCA method for making the components of the FTA and F. Incl after which used factor analysis to check the factor strength of the components. The study employed the estimation panel data regression technique for the final output and results which are as follows,

Results and Discussions

Descriptives

Date: 06/22/24 Time: 18:06
Sample: 2018 2023

	DR	LR	PR	AGENTS	ATMS	BANK	BRANCHES
Mean	26.18071	21.61277	35.27380	1.746223	0.096868	NA	0.122519
Median	28.33961	23.86551	4.553957	1.659368	0.098020	NA	0.122345
Maximum	57.24295	50.02763	526.8955	2.393457	0.103006	NA	0.125936
Minimum	4.054781	0.385112	0.063728	1.341134	0.089039	NA	0.119777
Std. Dev.	12.63273	12.52355	101.0010	0.380005	0.004916	NA	0.002346
Skewness	0.063744	-0.068211	3.292940	0.530734	-0.402012	NA	0.169583
Kurtosis	2.559205	2.445985	13.36595	1.887937	1.772797	NA	1.591841
Jarque-Bera	0.526383	0.813860	377.0669	5.908495	5.381201	NA	5.244865
Probability	0.768595	0.665691	0.000000	0.052118	0.067840	NA	0.072626
Sum	1570.843	1296.766	2116.428	104.7734	5.812058	NA	7.351122
Sum Sq. Dev.	9415.562	9253.512	601871.1	8.519830	0.001426	NA	0.000325
Observations	60	60	60	60	60	0	60

Date: 06/22/24 Time: 18:06
Sample: 2018 2023

	CELLULAR_	E_BANK_TR	GR	INTERNET__	IR	M__MONEY_	MOB_BANK
Mean	78.28731	9219.661	0.028983	21.58049	0.114167	482.1492	126.6657
Median	79.42594	7129.457	0.033950	19.98601	0.096250	474.4357	123.5485
Maximum	84.97000	14335.30	0.065100	34.05000	0.220000	727.4171	191.3141
Minimum	70.07945	5922.357	-0.012700	15.34000	0.065000	274.4344	57.18678
Std. Dev.	5.098388	3596.501	0.029317	6.164730	0.055439	168.7652	49.14546
Skewness	-0.327598	0.663017	-0.207402	1.158984	0.910369	0.133744	0.007090
Kurtosis	1.812584	1.505493	1.446229	3.122050	2.540207	1.490612	1.542141
Jarque-Bera	4.598093	9.979794	6.465666	13.46968	8.816241	5.874504	5.313884
Probability	0.100355	0.006806	0.039446	0.001189	0.012178	0.053011	0.070162
Sum	4697.238	553179.7	1.739000	1294.829	6.850000	28928.95	7599.945
Sum Sq. Dev.	1533.620	7.63E+08	0.050711	2242.230	0.181333	1680419.	142501.3
Observations	60	60	60	60	60	60	60

Date: 06/22/24 Time: 18:06
Sample: 2018 2023

	NO_OF_CR	NO_OF_DEB	ONLINE__T	OTC_TRANS	SIZE	WALLETS
Mean	1.24E-05	0.000206	185.2959	413.2501	28.27256	3472.065
Median	1.20E-05	0.000205	166.9309	367.3704	28.30534	3516.460
Maximum	1.42E-05	0.000244	324.7398	691.8369	29.52604	5865.435
Minimum	1.11E-05	0.000170	68.15410	301.1307	27.12009	1151.648
Std. Dev.	1.01E-06	2.45E-05	96.27781	134.8702	0.560369	1663.692
Skewness	0.589074	0.054327	0.251125	1.308005	0.039633	0.012733
Kurtosis	2.174251	1.927531	1.484848	3.297275	2.548177	1.601550
Jarque-Bera	5.174736	2.904991	6.369855	17.32971	0.526068	4.890776
Probability	0.075218	0.233986	0.041381	0.000173	0.768716	0.086693
Sum	0.000743	0.012388	11117.76	24795.01	1696.354	208323.9
Sum Sq. Dev.	6.05E-11	3.55E-08	546895.6	1073208.	18.52680	1.63E+08
Observations	60	60	60	60	60	60

Results of Factor Analysis

Here this study applied the and got the following results,

Factor analysis method using principal factors – variable: Fintech adoption

Factor Method: Principal Factors
Date: 06/11/24 Time: 12:36
Covariance Analysis: Ordinary Correlation
Sample: 2018 2023
Included observations: 60
Number of factors: Minimum average partial
Prior communalities: Squared multiple correlation
Note: Calculations employ generalized inverse of covariance matrix

	Loadings F1	Communality	Uniqueness
AGENTS	0.843326	0.711199	0.288801
CELLULAR__SUBS	0.944026	0.891184	0.108816
INTERNET___U...	0.936154	0.876385	0.123615
M__MONEY__A_C	0.988849	0.977822	0.022178
MOB_BANK_US...	0.982930	0.966152	0.033848
OTC_TRANS	0.542599	0.294414	0.705586
ONLINE__TRANS	0.956194	0.914307	0.085693

Factor	Variance	Cumulative	Difference	Proportion	Cumulative
F1	5.631463	5.631463	---	1.000000	1.000000
Total	5.631463	5.631463		1.000000	

	Model	Independence	Saturated
Discrepancy	0.208229	13.24920	0.000000
Parameters	14	7	28
Degrees-of-freedom	14	21	---

Factor analysis method using principal factors – variable: Financial Inclusion

Factor Method: Principal Factors
Date: 06/11/24 Time: 12:44
Covariance Analysis: Ordinary Correlation
Sample: 2018 2023
Included observations: 60
Number of factors: Minimum average partial
Prior communalities: Squared multiple correlation
Note: Calculations employ generalized inverse of covariance matrix

	Loadings F1	Communality	Uniqueness
ATMS	0.911456	0.830752	0.169248
BRANCHES	0.058315	0.003401	0.996599
E_BANK_TRANS	0.945445	0.893866	0.106134
NO_OF_DEBIT_...	0.954568	0.911201	0.088799
NO_OF_CREDIT...	0.980310	0.961008	0.038992
MOB_BANK_US...	0.949266	0.901106	0.098894
POS	0.940725	0.884964	0.115036

Factor	Variance	Cumulative	Difference	Proportion	Cumulative
F1	5.386297	5.386297	---	1.000000	1.000000
Total	5.386297	5.386297		1.000000	

	Model	Independence	Saturated
Discrepancy	0.128422	12.63605	0.000000
Parameters	14	7	28
Degrees-of-freedom	14	21	---

Results of Principal Component Analysis

Here this study applied the PCA technique and got the following results,

PCA result of variable: Financial Inclusion

Principal Components Analysis
Date: 06/11/24 Time: 12:43
Sample: 2018 2023
Included observations: 60
Computed using: Ordinary correlations
Extracting 7 of 7 possible components

Eigenvalues: (Sum = 7, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	5.567259	4.459941	0.7953	5.567259	0.7953
2	1.107318	0.895128	0.1582	6.674577	0.9535
3	0.212190	0.147241	0.0303	6.886767	0.9838
4	0.064949	0.016665	0.0093	6.951716	0.9931
5	0.048284	0.048284	0.0069	7.000000	1.0000
6	4.55E-16	5.77E-16	0.0000	7.000000	1.0000
7	-1.22E-16	---	-0.0000	7.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
ATMS	0.397323	-0.180482	0.594260	0.392467	-0.048394	-0.545769	-0.046687
BRANCHES	0.027002	0.937497	0.323403	0.018044	0.102242	0.062917	0.032305
E_BANK_TRANS	0.402225	0.165782	-0.455235	0.479457	-0.454245	0.093314	0.398205
NO_OF_DEBIT_...	0.413565	-0.140966	0.211955	-0.444219	0.267077	0.177078	0.681285
NO_OF_CREDIT...	0.414837	0.059671	0.047377	-0.562382	-0.592876	0.015593	-0.392538
MOB_BANK_US...	0.417973	-0.117070	0.102382	0.290450	0.305675	0.671728	-0.414842
POS	0.402235	0.154613	-0.526665	-0.133413	0.514390	-0.454590	-0.218813

Ordinary correlations:

	ATMS	BRANCHES	E_BANK_T...	NO_OF_D...	NO_OF_C...	MOB_BAN...	POS
ATMS	1.000000						
BRANCHES	-0.086630	1.000000					
E_BANK_TRANS	0.812471	0.199645	1.000000				
NO_OF_DEBIT_...	0.957758	-0.068825	0.860051	1.000000			
NO_OF_CREDIT...	0.898718	0.123972	0.930809	0.956527	1.000000		
MOB_BANK_US...	0.967553	-0.049823	0.906924	0.980792	0.939245	1.000000	
POS	0.787831	0.187213	0.964540	0.888776	0.924032	0.909577	1.000000

PCA result of variable: Fintech Adoption

Principal Components Analysis
Date: 06/11/24 Time: 12:27
Sample: 2018 2023
Included observations: 60
Computed using: Ordinary correlations
Extracting 7 of 7 possible components

Eigenvalues: (Sum = 7, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	5.699586	4.743679	0.8142	5.699586	0.8142
2	0.955908	0.641907	0.1366	6.655494	0.9508
3	0.314000	0.286792	0.0449	6.969494	0.9956
4	0.027208	0.023910	0.0039	6.996702	0.9995
5	0.003298	0.003298	0.0005	7.000000	1.0000
6	2.19E-16	4.09E-16	0.0000	7.000000	1.0000
7	-1.90E-16	---	-0.0000	7.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
AGENTS	0.356682	-0.307215	0.766515	0.050528	0.180722	0.394509	-0.000984
CELLULAR__SUBS	0.393497	-0.186082	-0.513251	-0.026933	0.705763	0.177021	0.130167
INTERNET___U...	0.390984	0.332349	-0.267784	0.045683	-0.409772	0.606581	-0.356408
M__MONEY__A_C	0.413526	-0.080431	0.012832	-0.834251	-0.231477	-0.248291	0.105630
MOB_BANK_US...	0.410587	-0.174521	-0.109102	0.459709	-0.409495	-0.164891	0.618749
OTC_TRANS	0.227328	0.846576	0.252802	0.038774	0.279498	-0.169857	0.243409
ONLINE__TRANS	0.416901	-0.083177	0.036652	0.292957	0.044028	-0.572186	-0.634644

Ordinary correlations:

	AGENTS	CELLULAR...	INTERNET...	M__MONE...	MOB_BAN...	OTC_TRANS	ONLINE__...
AGENTS	1.000000						
CELLULAR__SUBS	0.731454	1.000000					
INTERNET___U...	0.632614	0.859938	1.000000				
M__MONEY__A_C	0.866098	0.939755	0.894166	1.000000			
MOB_BANK_US...	0.860079	0.968187	0.869825	0.970580	1.000000		
OTC_TRANS	0.274597	0.319138	0.753956	0.470633	0.382203	1.000000	
ONLINE__TRANS	0.881212	0.943788	0.899839	0.982465	0.991846	0.476116	1.000000

After the PCA of the components study employed the regression panel data model and obtained the following results

Results of Panel Data Regression Analysis

Dependent Variable: DR
Method: Panel Least Squares
Date: 06/11/24 Time: 12:50
Sample: 2018 2023
Periods included: 6
Cross-sections included: 10
Total panel (balanced) observations: 60
White cross-section standard errors & covariance (d.f. corrected)
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	312.1469	229.2213	1.361771	0.1800
FINTECH	4.865998	1.991849	2.442956	0.0186
FI	-6.128813	0.444766	-13.77985	0.0000
GR	-22.02835	2.889352	-7.623974	0.0000
IR	48.55089	1.187274	40.89274	0.0000
SIZE	-10.28809	8.107870	-1.268901	0.2110

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.836293	Mean dependent var	26.18071
Adjusted R-squared	0.785362	S.D. dependent var	12.63273
S.E. of regression	5.852625	Akaike info criterion	6.583976
Sum squared resid	1541.395	Schwarz criterion	7.107562
Log likelihood	-182.5193	Hannan-Quinn criter.	6.788779
F-statistic	16.42008	Durbin-Watson stat	1.442579
Prob(F-statistic)	0.000000		

Dependent Variable: LR
Method: Panel Least Squares
Date: 06/11/24 Time: 13:07
Sample: 2018 2023
Periods included: 6
Cross-sections included: 10
Total panel (balanced) observations: 60
White cross-section standard errors & covariance (d.f. corrected)
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	226.1523	216.6609	1.043808	0.3021
FINTECH	2.901687	1.910285	1.518981	0.1358
FI	-5.067639	0.664976	-7.620783	0.0000
GR	-11.65724	4.306598	-2.706833	0.0096
IR	40.21565	2.822540	14.24804	0.0000
SIZE	-7.385004	7.659891	-0.964113	0.3401

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.838931	Mean dependent var	21.61277
Adjusted R-squared	0.788821	S.D. dependent var	12.52355
S.E. of regression	5.755103	Akaike info criterion	6.550369
Sum squared resid	1490.455	Schwarz criterion	7.073955
Log likelihood	-181.5111	Hannan-Quinn criter.	6.755172
F-statistic	16.74166	Durbin-Watson stat	1.427508
Prob(F-statistic)	0.000000		

Dependent Variable: PR
Method: Panel Least Squares
Date: 06/11/24 Time: 13:07
Sample: 2018 2023
Periods included: 6
Cross-sections included: 10
Total panel (balanced) observations: 60
White cross-section standard errors & covariance (d.f. corrected)
WARNING: estimated coefficient covariance matrix is of reduced rank

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2313.565	1014.608	-2.280255	0.0274
FINTECH	-11.02148	8.648947	-1.274315	0.2091
FI	-7.440433	2.247400	-3.310686	0.0018
GR	-70.81972	14.41883	-4.911614	0.0000
IR	69.17538	2.347292	29.47029	0.0000
SIZE	82.87164	35.87846	2.309788	0.0255

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.904549	Mean dependent var	35.27380
Adjusted R-squared	0.874854	S.D. dependent var	101.0010
S.E. of regression	35.73015	Akaike info criterion	10.20218
Sum squared resid	57448.97	Schwarz criterion	10.72577
Log likelihood	-291.0655	Hannan-Quinn criter.	10.40699
F-statistic	30.46057	Durbin-Watson stat	0.877084
Prob(F-statistic)	0.000000		

Dependent Variable: FI
Method: Panel Least Squares
Date: 06/23/24 Time: 05:50
Sample: 2018 2023
Periods included: 6
Cross-sections included: 10
Total panel (balanced) observations: 60

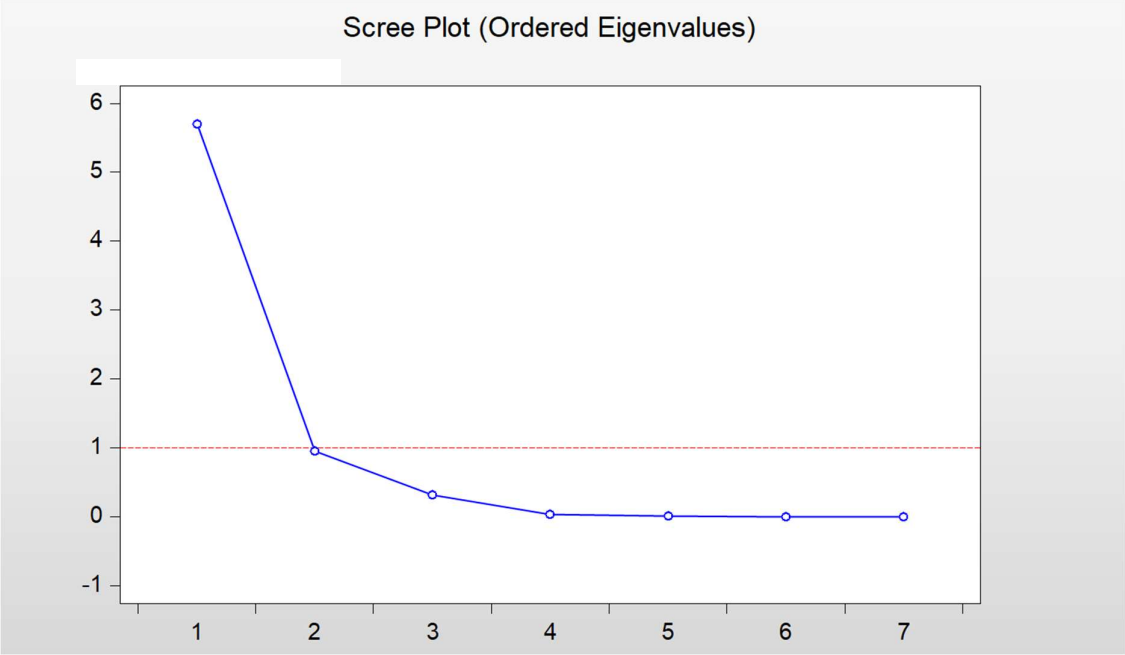
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.877705	1.589482	-0.552196	0.5831
FINTECH	0.711004	0.043527	16.33494	0.0000
GR	-0.960537	1.018963	-0.942662	0.3500
IR	5.596814	0.796476	7.026970	0.0000
SIZE	0.009429	0.056147	0.167930	0.8673

R-squared	0.961550	Mean dependent var	-5.14E-16
Adjusted R-squared	0.958754	S.D. dependent var	0.998225
S.E. of regression	0.202732	Akaike info criterion	-0.274211
Sum squared resid	2.260509	Schwarz criterion	-0.099682
Log likelihood	13.22632	Hannan-Quinn criter.	-0.205943
F-statistic	343.8565	Durbin-Watson stat	2.997639
Prob(F-statistic)	0.000000		

Dependent Variable: FINTECH
Method: Panel Least Squares
Date: 06/23/24 Time: 05:53
Sample: 2018 2023
Periods included: 6
Cross-sections included: 10
Total panel (balanced) observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.538424	2.030645	-0.757604	0.4519
FI	1.166101	0.071387	16.33494	0.0000
IR	-4.362724	1.276104	-3.418784	0.0012
GR	2.068141	1.285540	1.608772	0.1134
SIZE	0.069911	0.071303	0.980480	0.3311

R-squared	0.937932	Mean dependent var	-1.44E-15
Adjusted R-squared	0.933418	S.D. dependent var	1.006177
S.E. of regression	0.259630	Akaike info criterion	0.220533
Sum squared resid	3.707411	Schwarz criterion	0.395062
Log likelihood	-1.615993	Hannan-Quinn criter.	0.288801
F-statistic	207.7799	Durbin-Watson stat	3.268514
Prob(F-statistic)	0.000000		



Interpretation and Discussion

In preparation for the factors this study observed that the Fintech adoption (FTA) has factor OTC transactions and the fintech agents which are the strongest source of the fintech expansion in the country, similarly the factors like the cellular subscription and the internet users have also played much important role for the expansion of the fintech. Similarly, this study observed that F. incl has the strongest factor branches, ATM, and POS transactions which are responsible for F. incl in the country. During the PCA of both independent variables this study

found that for Fintech adoption, there is only one factor PC1 which is the first component that explains variable 81% so it means that it is representing the variable in a better way similarly another variable F. Incl which is represented by the PC1 component again which is explaining the variable 79% which is also good representer of the variable. Since almost in average 80% of the proportion is explained by the first component in both variables it means that it is enough to extract only one element for the financial inclusion and the fintech which is also confirmed by the scree plot.

Regression results tell us that the DR (Default risk) has a direct relationship with the IR and the Fintech which shows that the IR movement is not good for the fintech expansion in the country. It means that the increase in the fintech and the interest rate will raise the default risk due to the more exposure of the bank toward the new technological devices and projects focusing on the digitalization of payment and other financial systems. Here the DR P values are showing significant figures but in inverse relation when the per change comes in the F. incl and the growth in the country. This indicates that by increasing financial inclusion and GDP growth in the country the default risk of the financial institutions becomes low as the banks invest in new products and services open new branches and install new ATMS and POS thus increasing the financial reach of the banks to the unbanked sector of the country.

Similarly, the results of the LR show that fintech activities for the LR are not significant as they have no significant impact on the LR (P values are more than 0.05). however, the F. Incl, Interest rate and Growth in the GDP play a more important role as they have an impact on the LR. With an increase in Growth and Financial inclusion in the country the LR is decreasing thus today's banks can decrease their LR low by keeping the GDP growth and financial inclusion activities at optimum level. Here the Interest rate shows a positive relation as on increasing the interest rate the LR is increasing which is the guide for the policymakers to keep the bank rate low for the lower LR. Similarly, the results of the PR show that fintech activities for the PR are not significant as they have no significant impact on the PR (P values are more than 0.05). Growth and the F. Incl has the again negative relation with the PR which shows that per unit rise in the Growth of the GDP and the Financial inclusion index will cause the PR in the banking industry to lower by 7.4% and 70%. Here again the Here the Interest rate shows a positive relation as on increasing the interest rate the PR is increasing which is the guide for the policymakers to keep the bank rate low for the lower PR. Here in our result, last is the scree plot which shows that only one factor starts from the number 6 on the y-axis and ends at 1 on the x-axis which shows that there is only one responsible factor able to explain the relationship of the independent variable with the dependent variable.

Conclusion

Conclusion of the study

This study aimed to uncover the relationship between bank risk and financial technology adoption and financial inclusion in the country in the presence of few control variables. This study used the panel data regression model after the application of the PCA Method of reduction of data technique. This study found that fintech adoption in the banks is not producing any impact on the LR and PR of the banks, but it only produces a negative impact on the DR of the firms. Thus, before the adoption of Fintech in the different business processes proper homework and care should be exercised otherwise the blind following of the fintech investment can be risky for the banks in the country. This study also found that F. Incl and GDP Growth in every case produced inverse impacts on the DR, LR and PR of the banks. This guides the policymakers to accelerate the programs of F. incl which can help to augment the banking landscape in the country. Similarly, this study also confirms the positive relations between the fintech activities and the finances in the country.

Limitations & Policy Implications

This study has certain limitations such as it has focused on the adoption of fintech which is related to adoption trends in emerging economies, this study is related or limited only to the banking sector of Pakistan with a focus on the bank risk. Due to having limited data on fintech, this study has only taken the financial information from 2018 onwards. This study can be very important for policymakers to use the tools of fintech and F. Incl for controlling bank risk. It can be helpful for the SBP not only for the research literature of F. Incl but also in the corporate sector for making policies to avoid the risk of default, liquidity and the portfolio while adopting Fintech in the companies in different business processes.

Implication for further research

In light of this study, many diverse areas can be checked with the fintech and F. incl such as efficiency, performance or corporate governance of the banking sector. This study can also be done in comparison of financial sub-sectors or with the other sectors in which there is potential to come across the fintech in coming areas, similarly, fintech adoption can be gauged in different countries in cross-country comparison.

Conflict of interest

There is no conflict of interest associated with the present study.

Acknowledgment

The authors are thankful to the Course Associate Professors & colleagues for their guidance & support in the preparation & improvement of the article.

References

Aduba, J. Jr., Asgari, B., & Izawa, H. (2022). Causality between Financial Performance, Fintech, Financial Inclusion, and Financial Development in Emerging and Developing Economies: A Cross Country Analysis [Preprint]. SSRN. https://doi.org/10.2139/ssrn.4113175

Ahamadou, M., & Agada, D. B. (2023). Adopting FinTech to promote financial inclusion: Evidence from western African economic and monetary union. International Journal of Applied Economics, Finance and Accounting, 17(1), 135–145. https://doi.org/10.33094/ijaefa.v17i1.1090

Aleemi, A. R., Javaid, F., & Hafeez, S. S. (2023). Finclusion: The nexus of Fintech and financial inclusion against banks' market power. Heliyon, 9(12), e22551. https://doi.org/10.1016/j.heliyon.2023.e22551

Allen, F., Demirguc-Kunt, A., Klapper, L., & Peria, M. S. M. (2016). The foundations of financial inclusion: Understanding ownership and use of formal accounts.

Arpita et al. (2023). G20 policy recommendations for advancing financial inclusion and productivity gains through digital public infrastructure [Official report]. the World Bank.

Ashenafi, B. B., & Dong, Y. (2022). Financial Inclusion, Fintech, and Income Inequality in Africa. FinTech, 1(4), 376–387. https://doi.org/10.3390/fintech1040028

Asif, M., Khan, M. N., Tiwari, S., Wani, S. K., & Alam, F. (2023). The Impact of Fintech and Digital Financial Services on Financial Inclusion in India. Journal of Risk and Financial Management, 16(2), 122. https://doi.org/10.3390/jrfm16020122

Banna, H., & Alam, M. R. (2021). Does digital financial inclusion matter for bank risk-taking? Evidence from the dual-banking system. Journal of Islamic Monetary Economics and Finance, 7(2), 401–430. https://doi.org/10.21098/jimf.v7i2.1320

Banna, H., Kabir Hassan, M., & Rashid, M. (2021). Fintech-based financial inclusion and bank risk-taking: Evidence from OIC countries. Journal of International Financial Markets, Institutions and Money, 75, 101447. https://doi.org/10.1016/j.intfin.2021.101447

Banna, H., Mia, M. A., Nourani, M., & Yarovaya, L. (2022). Fintech-based Financial Inclusion and Risk-taking of Microfinance Institutions (MFIs): Evidence from Sub-Saharan Africa. Finance Research Letters, 45, 102149. https://doi.org/10.1016/j.frl.2021.102149

Beck, T. (2020). Fintech and financial inclusion: Opportunities and pitfalls. 1165.

Croutzet, A., & Dabbous, A. (2021). Do FinTech trigger renewable energy use? Evidence from OECD countries. Renewable Energy, 179, 1608–1617. https://doi.org/10.1016/j.renene.2021.07.144

Demir, A., Pesqué-Cela, V., Altunbas, Y., & Murinde, V. (2022). Fintech, financial inclusion and income inequality: A quantile regression approach. The European Journal of Finance, 28(1), 86–107. https://doi.org/10.1080/1351847X.2020.1772335

djoufouet & pondie. (2023). Impacts of fintech on financial inclusion: the case of sub-saharan africa. Copernican Journal of Finance & Accounting, 11(4), 69–88. https://doi.org/10.12775/CJFA.2022.019

Elahi, E. (2022). Fintech, Bank Risk-Taking, and Risk-Warning for Commercial Banks in the Era of Digital Technology. Frontiers in Psychology, 13.

Elzahi Saaid Ali, A., Ali, K. M., & Khaleequzzaman, M. (Eds.). (2020). Enhancing Financial Inclusion through Islamic Finance, Volume I. Springer International Publishing. https://doi.org/10.1007/978-3-030-39935-1

Herrerias, R., & Alvarez, C. M. O. (2023). Financial Behavior and Degrees of Financial Inclusion [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2982432/v1

K. Ozili, P. (2023). Determinants of FinTech and BigTech lending: The role of financial inclusion and financial development. Journal of Economic Analysis, 33. https://doi.org/10.58567/jea02030004

Lee, C.-C., Li, X., Yu, C.-H., & Zhao, J. (2021). Does fintech innovation improve bank efficiency? Evidence from China's banking industry. International Review of Economics & Finance, 74, 468–483. https://doi.org/10.1016/j.iref.2021.03.009

Lihonga & Keda. (2022). Fintech, Bank Risks, and Business Performance: From the Perspective of Inclusive Finance. Studies of International Finance, 5(2), 242–261. https://doi.org/10.3868/s060-014-022-0012-8

Makina, D. (2019). The Potential of FinTech in Enabling Financial Inclusion. In Extending Financial Inclusion in Africa (pp. 299–318). Elsevier. https://doi.org/10.1016/B978-0-12-814164-9.00014-1

Metawa, N., Itani, R., Metawa, S., & Elgayar, A. (2023). The impact of digitalization on credit risk: The mediating role of financial inclusion (National Bank of Egypt (NBE) case study). Economic Research-Ekonomska Istraživanja, 36(2), 2178018. https://doi.org/10.1080/1331677X.2023.2178018

Musau, S., Muathe, S., & Mwangi, L. (2017). Financial Inclusion, Bank Competitiveness and Credit Risk of Commercial Banks in Kenya. International Journal of Financial Research, 9(1), 203. https://doi.org/10.5430/ijfr.v9n1p203

Noori, S., Meena, A. R., & Batra, G. (2023). Financial Inclusion Initiatives in India: A Review.

Ozili, P. K. (2021). Financial inclusion research around the world: A review. Forum for Social Economics, 50(4), 457–479. https://doi.org/10.1080/07360932.2020.1715238

Sarma, M. (2008). Index of Financial Inclusion.

Sarma, M., & Pais, J. (2011). Financial Inclusion and Development. Journal of International Development, 23(5), 613–628. https://doi.org/10.1002/jid.1698

SBP. (2015). National Financial Inclusion Strategy Pakistan (pp. 1–55).

Shihadeh, F. (2020). The influence of financial inclusion on banks' performance and risk: New evidence from MENAP. Banks and Bank Systems, 15(1), 59–71. https://doi.org/10.21511/bbs.15(1).2020.07

Shihadeh, F., & Liu, B. (2019). Does financial inclusion influence the banks risk and performance? Evidence from global prospects. 23(3).

Siddharth & Kumar. (2023). Impact of Fintech on Sustainable Financial Inclusion – A Theoritical Model Approach. European Economic Letters, Vol 13(Issue 5 (2023)), 1–9. https://doi.org/10.52783/eel.v13i5.835

Wang, R., & Liu, J. (2020). Fintech development and bank risk taking in China.

Yang, F., & Masron, T. A. (2023). Impact of Digital Transformation on Bank Credit Risk: The Moderating Effect of Financial Inclusion [Preprint]. SSRN. https://doi.org/10.2139/ssrn.4531690

Yang, H. (2019). Fintech as a Strategy of Financial Inclusion in the Age of Digitalization. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3554976